Cer2-2011 - Starter Phosphorus Increases Winter Wheat Yields!

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Starter Phosphorus Increases Winter Wheat Yields!

Purpose:

Adequate P and K fertility is essential for producing high, economically competitive, winter wheat yields. Because of increasing P and K fertilizer prices, wheat producers need to efficiently apply P and K fertilizers in order to maximize profits. The purpose of this project is to evaluate liquid and dry starter fertilizers for their ability to increase winter wheat yields and profits and to evaluate the impact that soil P and K fertility have on wheat yields and yield response to application of starter fertilizers.

Methods:

This project was started in the fall of 2009 and to date has collected data from 2 growing seasons (2010 and 2011). For each year, 7 replicated on-farm trials were conducted which evaluated soft red winter wheat response to starter fertilizers (a total of 14 over 2010 and 2011). In 2011, hard red winter wheat response to starter fertilizers were also evaluated on an additional 2 replicated on-farm trials. Plots were large enough to use cooperating farmers commercial combines, so plots were typically 20-30ft wide by length of the field. All yields were recorded using weigh wagons. Except for starter fertilizers, wheat was produced using the cooperating farmers production practices which are summarized in Table 1 along with the site soil P (as P_2O_5) and soil K (as K_2O) fertility. Wheat was always planted following either soybeans or edible beans. None of the sites had manure applied in the previous 2 years.

The various starter fertilizers applied, associated costs, N, P and K application rates and break even wheat yields are summarized in Table 2. Fertilizer P rates in this report are expressed as P_2O_5 and fertilizer K is expressed as K_2O. Starters common to both years of this project were liquid 6-24-6 applied at rates of 2.5, 5 and 10 gal/ac with seed (in-furrow); dry granular 7-34-20 applied at 40 lb/ac with seed and 7-34-20 applied preplant broadcast at 200 lb/ac. 7-34-20 is a 2:1 mixture of MAP and Potash. A high rate 7-34-20 applied with seed was also evaluated and applied at 100 lb/ac in 2010 and 150 lb/ac in 2011. The rate was increased in 2011 to serve as a direct comparison to MAP ((11-52-0) which was applied at 100 lb/ac with the seed in the 2011 trials. The amount of N and P applied by 100 lb/ac of MAP and 150 lb/ac of 7-34-20 is the same. MicroEssentials SZ (MESZ) (12-40-0-10S-1Zn) was also a starter treatment applied to the 2011 trials.

The starter treatments for the third year of this project have been established on 9 on-farm sites in the fall of 2011. Starter treatments established in the third year (2012) of this project were the same as the starter treatments for the second year (2011).

Table 1. Production practices and soil P and K fertility associated with the various on-farm trials evaluating red winter wheat response to starter fertilizers in 2010 and 2011.

Sites	County	Planting Date	Spring N Rate lb-N/ac	Soil P ppm	Soil K ppm	Soil O.M. %
2010 Soft Red						
Atwood	Perth	Oct 19	120	16	138	3.8
Belmont	Elgin	Oct 20	120	18	116	2.8
Ingersoll-M	Oxford	Oct 20	90	18	91	
Ingersoll-R	Oxford	Oct 14	90	27	102	
Lucan	Middlesex	Oct 18	120	25	131	3.5
Perth Demo	Perth	Oct 21	90	8	56	4.1
St. Marys	Perth	Oct 15	120	37	107	4.1
2011 Soft Red						
Arthur	Wellington	Oct 11	120	10	105	4.1
Atwood	Perth	Oct 10	120	13	130	4.2
Belmont	Elgin	Oct 19	120	21	120	3.6
Dutton	Elgin	Oct 20	120	23	157	3.9
Ingersoll	Oxford	Sep 30	120	26	82	2.1
Lucan	Middlesex	Oct 01	90	6	73	4.2
Perth Demo	Perth	Oct 08	90	18	80	
2011 Hard Red						
Jarvis	Haldimand	Oct 18	120	8	116	3.5
Plattsville	Oxford	Oct 18	135	10	88	2.9

Results:

Soft Red in 2010

Soft red wheat yields were increased by starter fertilizers at five of seven sites in 2010 (Table 3). The non-responsive 2010 sites (Ingersol-R and St. Marys) had soil-test P levels greater than 26 ppm, soil-test K levels greater than 100 ppm and were relatively high yielding with yields where No Starter was applied that were over 6000 kg/ha (89 bu/ac).

Applying liquid 6-24-6 with seed at rates of 2.5, 5 or 10 gal/ac substantially increased yield only at the Ingersol-M site in 2010 (Table 3). The yield increase at the Ingersol-M site associated with applying 6-24-6 was more than enough to cover the cost of 6-24-6 for all 3 rates.

At the five 2010 responsive sites, applying 7-34-20 with the seed at 40 lb/ac increased yield by 290 to 700 kg/ha (4 to 10 bu/ac) (Table 3). The breakeven yield response to pay for 40 lb/ac of 7-34-20 is 2.5 bu; so each of the 5 responsive sites had yield increases associated with 40 lb/ac of 7-34-20 that were large enough to cover the cost of the fertilizer.

The Perth Demo site had the lowest soil-test P and soil-test K levels in 2010 and the 100 lb/ac rate of 7-34-20 produced 620 kg/ha (9 bu/ac) more wheat than the 40 lb/ac rate of 7-34-0 (Table 3). The 100 lb/ac rate of 7-34-20 tended to produce slightly higher yields at the other responsive sites in 2010, but the yield increases were not large enough to cover the added cost of fertilizer.

Preplant broadcast 7-34-20 at 200 lb/ac did not produce yields that were greater than when 100 lb/ac was applied with the seed (Table 3).

Soft Red in 2011

Soft red wheat yields were increased by starter fertilizers at five of seven sites in 2011 (Table 3). The non-responsive 2011 Belmont site had soil-test P of 21 ppm, soil-test K of 120 ppm and was relatively high yielding with No Starter yields that were 7550 kg/ha (112 bu/ac). The Perth Demo site in 2011 also was not responsive to starter fertilizer in spite of low soil-test K levels (80 ppm) and yields were low with the no starter treatment producing only 4510 kg/ha (67 bu/ac).

At three of seven 2011 sites, applying 5 or 10 gal/ac of 6-24-6 produced yields that were more than 700 kg/ha (11 bu/ac) compared to where no starter was applied (Table 3). The most economic rate of 6-24-6 was 2.5 gal/ac at Atwood (soil-test P of 13 ppm), 5 gal/ac at Arthur (soil-test P of 10 ppm) and 10 gal/ac at Lucan (soil-test P of 8 ppm).

At the same 2011 sites with significant yield responses associated with applying 6-24-6, applying 40 lb/ac of 7-34-20 with the seed increased yields by 900 to 1000 kg/ha (13 to 15 bu/ac) (Table 3). Applying 40 lb/ac of 7-34-20 produced yields that were similar to those produced when 5 gal/ac of 6-24-6 was applied. The cost of 40 lb/ac of 7-34-20 is about half of 5 gal/ac of 6-24-6; so 40 lb/ac of 7-34-20 is as effective, and a more profitable, alternative to liquid 6-24-6 for wheat producers who are able to apply dry starter fertilizers.

Applying 150 lb/ac of 7-34-20 with the seed also increased wheat yields at the same 2011 sites where 40 lb/ac of 7-34-20 increased yields (Table 3). In each case, 150 lb/ac produced slightly higher wheat yields, ranging from 150 to 300 kg/ha (3 to 5 bu/ac) more than where 40 lb/ac of 7-34-20 was applied.

Applying 100 lb/ac of MAP wit the seed produced yields that were essentially similar to where 150 lb/ac of 7-34-20 was applied (Table 3). Since both products applied the same rate of MAP, this suggests that K was not a necessary component of a starter fertilizer for wheat at these sites.

Table 2. Starter fertilizers, nutrient rates applied and assumed starter cost associated with the various starter fertilizer treatments included in the 2010 and 2011 trials.

Starter[+]	Starter Rate	Year Applied	Starter Cost[++] $/ha ($/ac)	Nutrient Applied			Break Even Yield[+++] (bu/ac)
				N	P	K	
				-------- kg/ha (lb/ac) --------			
6-24-6	23.4 l/ha (2.5 gal/ac)	2010 & 2011	38 (15)	1.9 (1.7)	7.5 (6.7)	1.9 (1.7)	2.5
6-24-6	46.7 l/ha (5.0 gal/ac)	2010 & 2011	75 (31)	3.7 (3.3)	14.9 (13.3)	3.7 (3.3)	5.1
6-24-6	93.5 l/ha (10.0 gal/ac)	2010 & 2011	151 (61)	7.5 (6.7)	29.8 (26.6)	7.5 (6.7)	10.2
MAP (11-52-0)	112 kg/ha (100 lb/ac)	2011	91 (37)	12.3 (11.0)	58.2 (52.0)	0.0 (0.0)	6.1
MESZ[++++]	112 kg/ha (100 lb/ac)	2011	94 (38)	13.4 (12.0)	44.8 (40.0)	0.0 (0.0)	6.4
7-34-20	45 kg/ha (40 lb/ac)	2010 & 2011	35 (14)	3.1 (2.8)	15.2 (13.6)	9.0 (8.0)	2.4
7-34-20	112 kg/ha (100 lb/ac)	2010	87 (35)	7.8 (7.0)	38.1 (34.0)	22.4 (20.0)	5.9
7-34-20	168 kg/ha (150 lb/ac)	2011	131 (53)	11.8 (10.5)	57.1 (51.0)	33.6 (30.0)	8.8
7-34-20 (Broadcast)	224 kg/ha (200 lb/ac)	2010 & 2011	175 (71)	15.7 (14.0)	76.2 (68.0)	44.8 (40.0)	11.8

+ Unless otherwise stated, fertilizer was band applied with seed.

++ Application cost based on price of liquid 6-24-6 at $1.60/l ($6.10/gal); MAP (11-52-0) at $810/tonne; 7-34-20 at $780/tonne and MESZ (12-40-0-10S-1Zn) at $840/tonne.

+++ Break even yield calculated by dividing fertilizer cost by wheat price assumed to be $220/tonne or $6.00/bu.

++++ MicroEssentials SZ (12-40-0-10S-1Zn).

Table 3. Soft red winter wheat yield response to starter fertilizers observed on each of the 2010 and 2011 sites.

2010 Starter	Atwood	Belmont	Ingersoll-M	Ingersoll-R	Lucan	Perth Demo	St. Marys
	---------- bu/ac ----------						
6-24-6 @ 2.5 gal/ac	88 ab+	98 b	92 ab	96 a	112 ab	77 c	95 a
6-24-6 @ 5 gal/ac	89 ab	101 b	84 cd	96 a	112 ab	83 b	95 a
6-24-6 @ 10 gal/ac	90 ab	102 ab	98 a	98 a	115 ab	83 b	97 a
7-34-20 @ 40 lb/ac	90 ab	105 ab	87 bc	97 a	116 ab	81 bc	97 a
7-34-20 @ 100 lb/ac	94 a	108 a	88 bc	99 a	117 a	91 a	97 a
7-34-20 @ 200 lb/ac Broadcast	91 ab	102 ab	91 b	96 a	115 ab	84 b	101 a
No Starter	84 b	100 b	77 d	94 a	110 b	77 c	97 a
2011 Starter	**Arthur**	**Atwood**	**Belmont**	**Dutton**	**Ingersoll**	**Lucan**	**Perth Demo**
	---------- bu/ac ----------						
6-24-6 @ 2.5 gal/ac	96 bc+	103 ab	111 a	54 ab	89 b	74 cd	69 a
6-24-6 @ 5 gal/ac	105 ab	102 b	111 a	55 ab	85 b	79 bc	64 a
6-24-6 @ 10 gal/ac	108 a	100 b	113 a	56 ab	88 b	87 a	70 a
7-34-20 @ 40 lb/ac	105 a	104 ab	112 a	53 ab	91 b	82 ab	67 a
7-34-20 @ 150 lb/ac	108 a	107 ab	116 a	57 a	88 b	87 a	68 a
MAP @ 100 lb/ac	106 a	110 a	116 a	60 a	88 b	87 a	66 a
MESZ @ 100 lb/ac	105 a	109 a	113 a	54 ab	99 a	86 ab	68 a
7-34-20 @ 200 lb/ac Broadcast	102 ab	107 ab	115 a	56 ab	90 b	83 ab	67 a
No Starter	92 c	89 c	112 a	50 b	86 b	68 d	67 a

+ Within column (site) yields followed by the same letter are not different at the 10% level of probability.

MicroEssentials SZ (MESZ) applied with the seed at 100 lb/ac increased yield over MAP and 7-34-20 by about 720 kg/ha (11 bu/ac) at the 2011 Ingersol site (Table 3). This is the only site where MSZN produced higher yields than MAP; suggesting that the site may have been deficient in either zinc or sulphur.

Preplant broadcast 7-34-20 at 200 lb/ac did not produce yields that were greater than when 150 lb/ac was applied with the seed (Table 3).

Hard Red in 2011

Applying 5 gal of 6-24-6 with seed at the 2 hard red sites in 2011 increased yield by at least 590 kg/ha (9 bu/ac) (Table 4). Higher yields were produced when 10 gal/ac of 6-24-6 was applied with the seed; however the yield increase was not large enough to cover the cost of the added fertilizer.

On average, 40 lb/ac of 7-34-20 applied with seed produced yields that were equal to 5 gal/ac of 6-24-6 (Table 4). Since 40 lb/ac of 7-34-20 is half the cost of 5 gal of 6-24-6, applying 7-34-20 as a starter is probably an equally effective, and more profitable, alternative to liquid 6-24-6 for hard red wheat producers who are able to apply dry starter fertilizers.

The 150 lb/ac rate of 7-34-20 produced among the highest yields at the two 2011 hard red sites (Table 4). Both sites had low soil-test P levels (8 to 10 ppm) and as a consequence produced yields that were about 400 kg/ha (6 bu/ac) more than where 40 lb/ac of 7-34-20 was applied.

Applying 100 lb/ac of MAP resulted in yield increases that were similar to 150 lb/ac of MAP (Table 4); suggesting that most of the yield response associated with starter fertilizer at the 2011 hard red sites was due to P and not K. MicroEssentials SZ at 100 lb/ac did not produce yields that were higher than MAP applied with seed at 100 lb/ac.

Preplant broadcast 7-34-20 at 200 lb/ac did not produce yields that were higher when compared to lower rates of 7-34-20 that were applied with the seed at both of the 2011 hard red sites (Table 4).

Soil P and K Fertility and Wheat Yield Potential

Here are some of the key observations in regards to wheat yield potential, and soil P and K fertility:

1) Larger yield increases associated with applying starter occur with lower soil-test P.
2) For soil-test P levels above 13 ppm, yield increases were generally smaller, and a low rate of starter (ie. 13 lb-P/ac) often was all that was needed to economically optimize yields.
3) Large responses to starter are observed across a range of soil-test K. The wheat yield increases associated with applying starter fertilizers are primarily due to addition of phosphorus. When high yield response to starter fertilizer is observed for sites with relatively high soil-test K; their soil-test P levels are relatively low (less than 13 ppm).
4) Starter K may not significantly increase yields when soil-test P levels are relatively high and soil-test K levels are low.

5) Higher wheat yields (over 90 bu/ac) were associated with soil-test K levels over 100 ppm. Seven of the 16 sites with no starter yields that were over 90 bu/ac had soil test K levels over 100 ppm.
6) On sites where applying starter increased yields over 95 bu/ac, soil-test K levels were over 100 ppm.
7) Soil-test K levels over 100 ppm did not always produce high yields, but sites that produced higher wheat yields were associated with soil-test K levels that were over 100 ppm.
8) This suggests that in order to produce high wheat yields that soil K levels may have to be built to, or maintained at, a minimum of 100 ppm.

Table 4. Hard red winter wheat yield response to starter fertilizers observed on each of the 2011 sites.

Starter	Jarvis	Plattsville
	----- bu/ac -----	
6-24-6 @ 2.5 gal/ac	64 cde+	81 cd
6-24-6 @ 5 gal/ac	63 de	87 ab
6-24-6 @ 10 gal/ac	68 bcd	90 a
7-34-20 @ 40 lb/ac	68 bcd	83 bc
7-34-20 @ 150 lb/ac	73 a	89 a
MAP @ 100 lb/ac	72 ab	86 abc
MESZ @ 100 lb/ac	68 bc	81 cd
7-34-20 @ 200 lb/ac Broadcast	62 e	83 bc
No Starter	54 f	77 d
+ Within column (site) yields followed by the same letter are not different at the 10% level of probability.		

Summary:

Another field season of data will be collected for this project. Some preliminary conclusions based on the first 2 years of data are:

1. Applying starter fertilizers with seed will increase winter wheat yield especially when soil-test P levels are less than 13 ppm. On soils with soil-test P levels over 13 ppm, applying starter P with seed at rates of about 15 lb-P/ac should economically optimize yields. Higher rates of starter should be applied when soil-test P levels are less than 13 ppm in order to maximize wheat profit potential.
2. Dry granular fertilizers are as effective as liquid 6-24-6 for increasing wheat yields. Since dry fertilizers are significantly lower costing than liquid fertilizers,

use of dry starter fertilizers will likely provide higher profits for wheat producers who are able to apply dry starter fertilizers.

3. Applying starter P can supply adequate P nutrition for wheat to produce high yields and attain maximum yield potential. However, this project suggests that applying Starter K has relatively small potential to increase wheat yields even on low-testing K soils and that soil-test K levels may have to be built to and/or maintained at a minimum of 100 ppm to be able to attain maximum potential yields.

Next Steps:

Field sites have been identified and starter fertilizer treatments applied for year 3 trials associated with this project. The project is currently funded in order to complete 3 years (end of 2012).

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